

Online Appendix
“The COVID-19 shock and challenges for inflation modelling”

Elena Bobeica and Benny Hartwig*

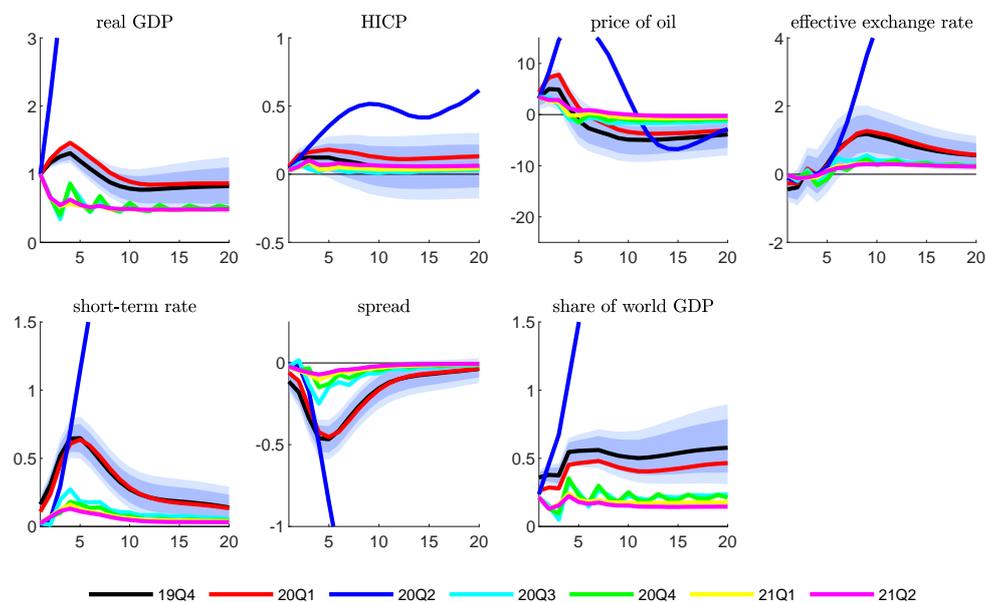
This appendix contains charts in colour. Use a colour printer for best results.

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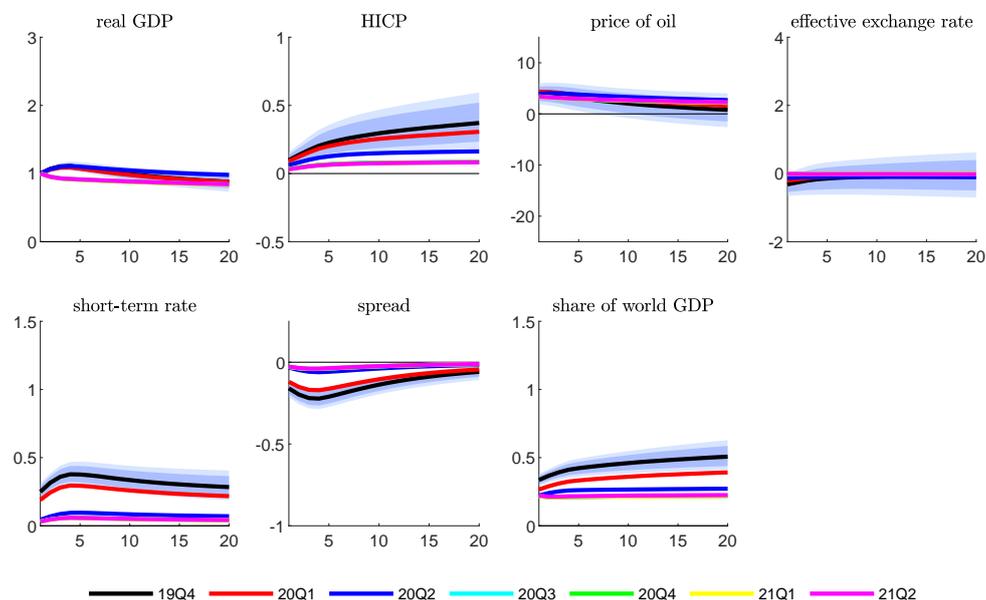
B Supplementary Figures and Tables

BVAR with Gaussian errors

Figure B.1: Impulse response functions in a small BVAR (various prior distributions)



(a) Weakly informative prior

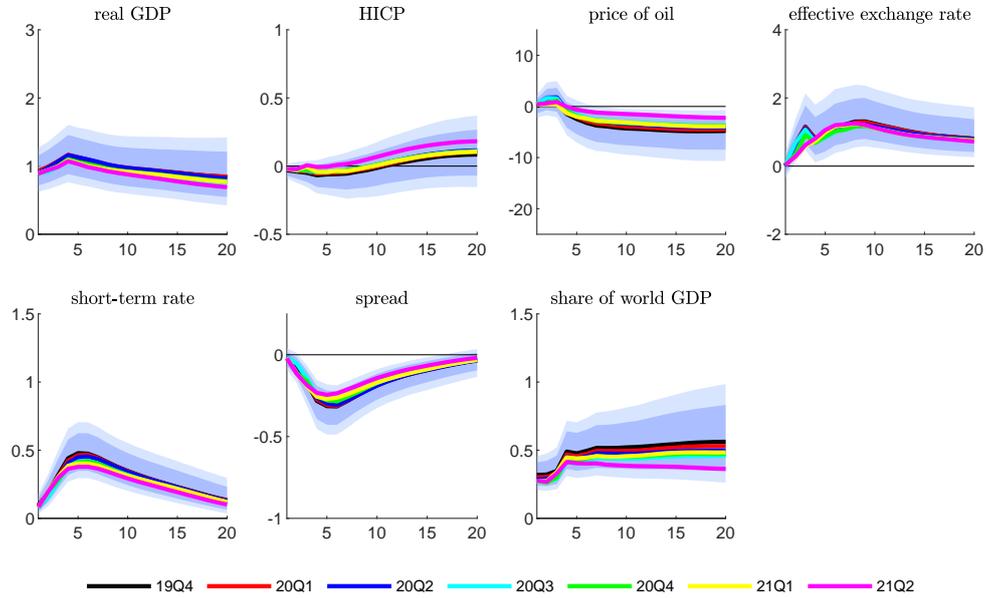


(b) Strong Sims and Zha prior

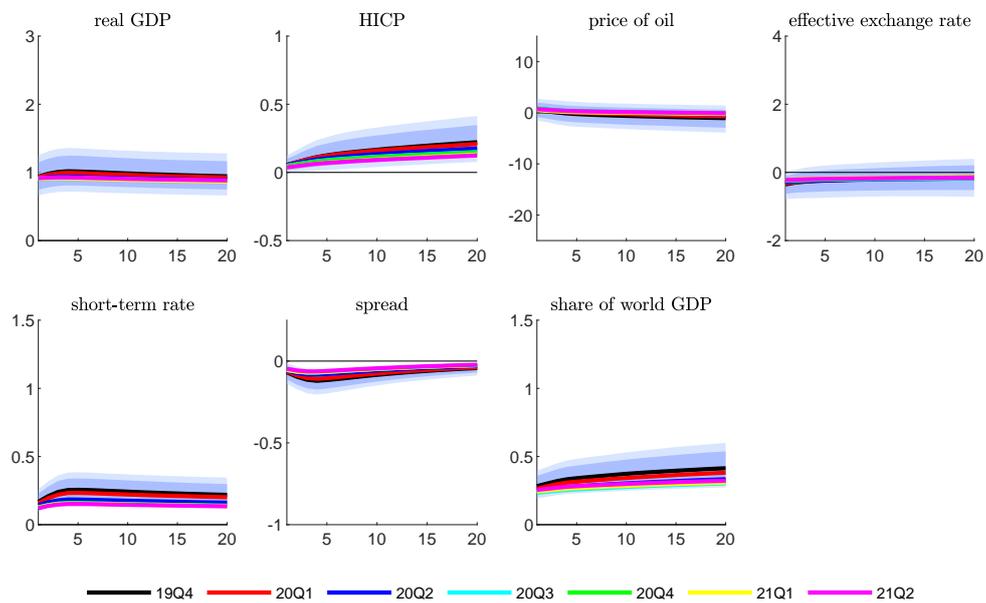
Note: Impulse response functions to a one standard deviation shock in real GDP from a BVAR with Gaussian errors with (a) weakly informative prior and (b) strong Sims and Zha prior. Coloured thick lines are median estimates, and the dark (light) blue area is the 68% (90%) credible interval for the estimation window until 2019:Q4.

BVAR with fat-tailed errors

Figure B.2: Impulse response functions in a small BVAR- t (various prior distributions)



(a) Weakly informative prior

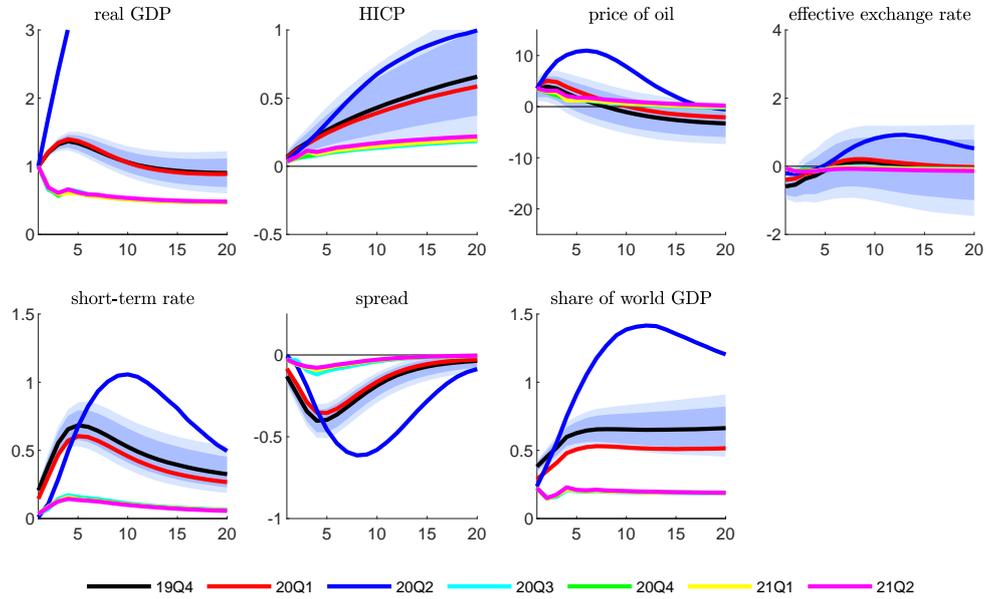


(b) Strong Sims and Zha prior

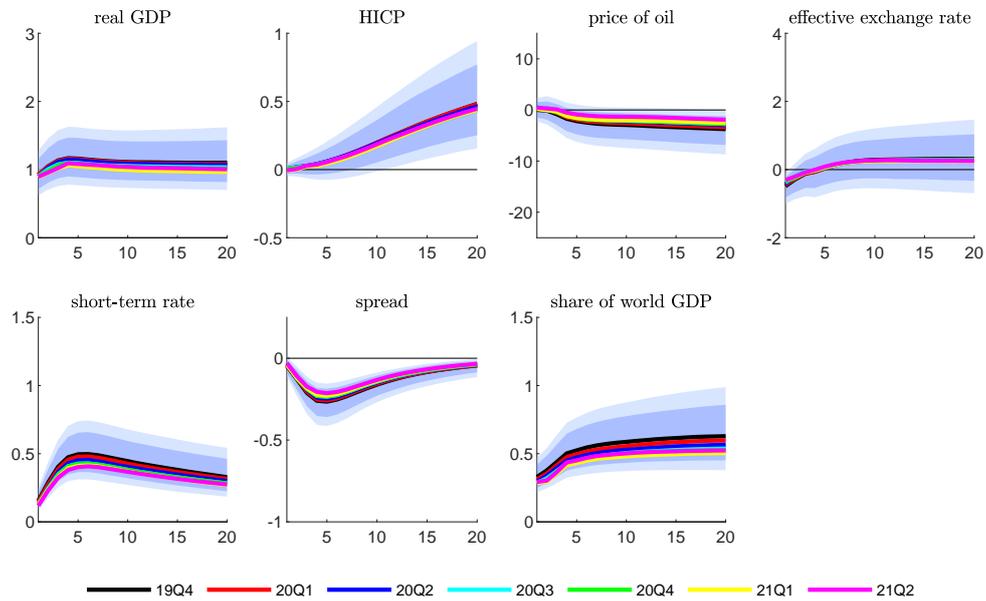
Note: Impulse response functions to a one standard deviation shock in real GDP from a BVAR with multivariate t -distributed errors with (a) weakly informative prior and (b) strong Sims and Zha prior. Coloured thick lines are median estimates, and the dark (light) blue area is the 68% (90%) credible interval for the estimation window until 2019:Q4.

Small BVAR with fixed Sims and Zha prior

Figure B.3: Impulse response functions with pre-COVID prior distribution



(a) Gaussian BVAR with pre-COVID Sims and Zha prior

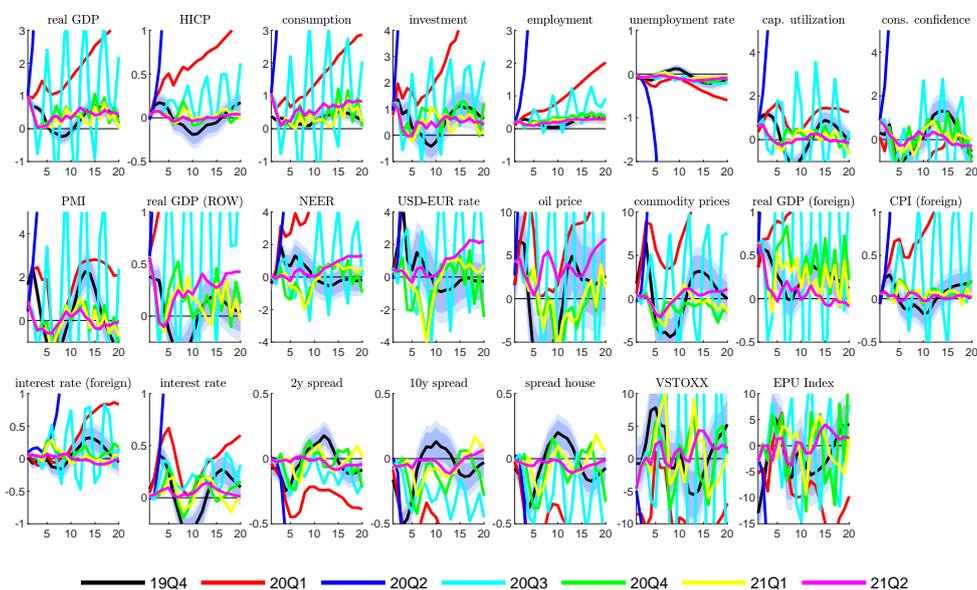


(b) Fat-tailed BVAR with pre-COVID Sims and Zha prior

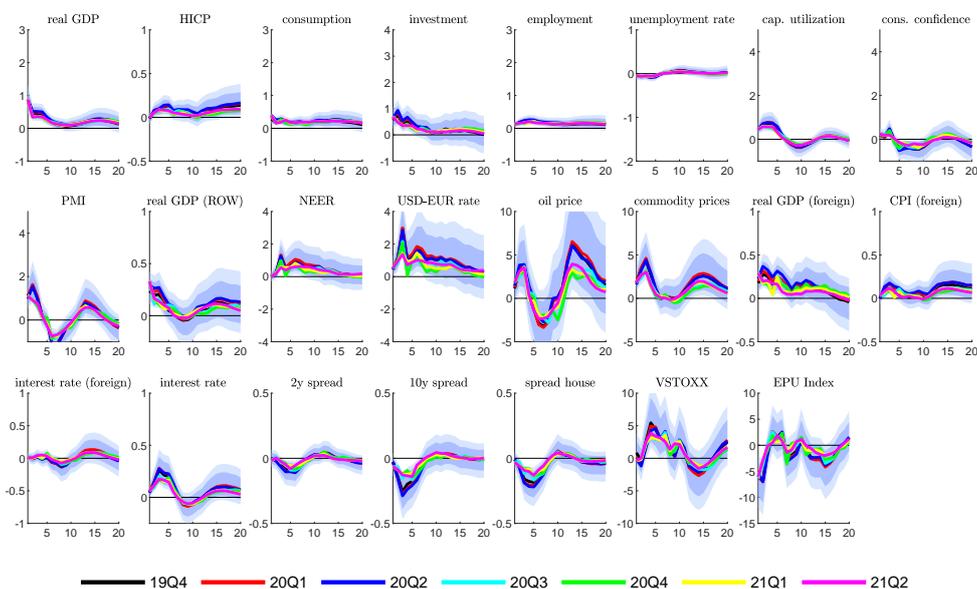
Note: Impulse response functions to a one standard deviation shock in real GDP with pre-COVID Sims and Zha prior from a (a) BVAR with Gaussian errors and (b) BVAR with multivariate t -distributed errors. Coloured thick lines are median estimates, and the dark (light) blue area is the 68% (90%) credible interval for the estimation window until 2019:Q4.

Additional results for the large BVAR

Figure B.4: Impulse response functions in a large BVAR (weakly informative prior)



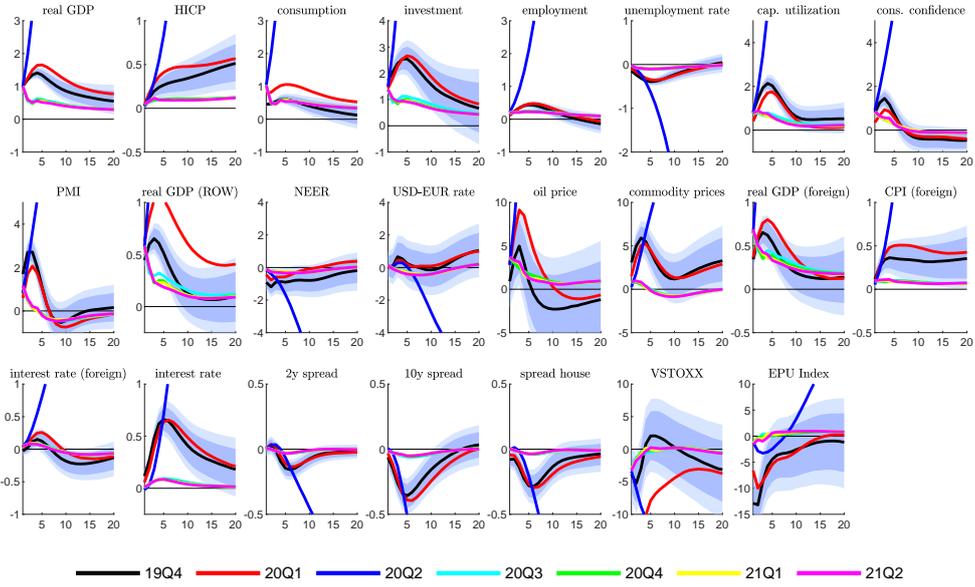
(a) BVAR with Gaussian errors



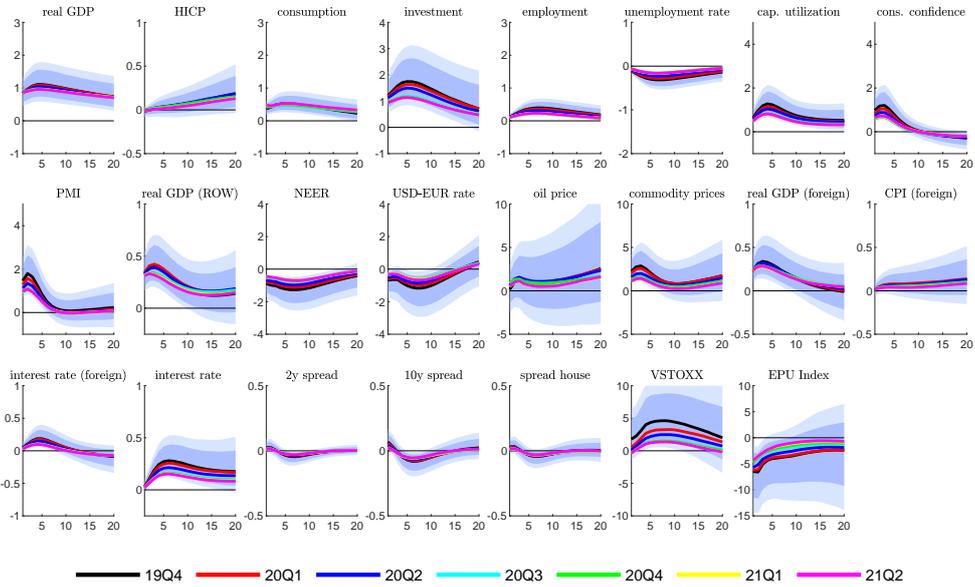
(b) BVAR with fat-tailed errors

Note: Impulse response functions to a one standard deviation shock in real GDP from a large BVAR with (a) Gaussian and (b) multivariate t -distributed errors using a weakly informative prior. Coloured thick lines are median estimates, and the dark (light) blue area is the 68% (90%) credible interval for the estimation window until 2019:Q4.

Figure B.5: Impulse response functions in a large BVAR (Sims and Zha prior)



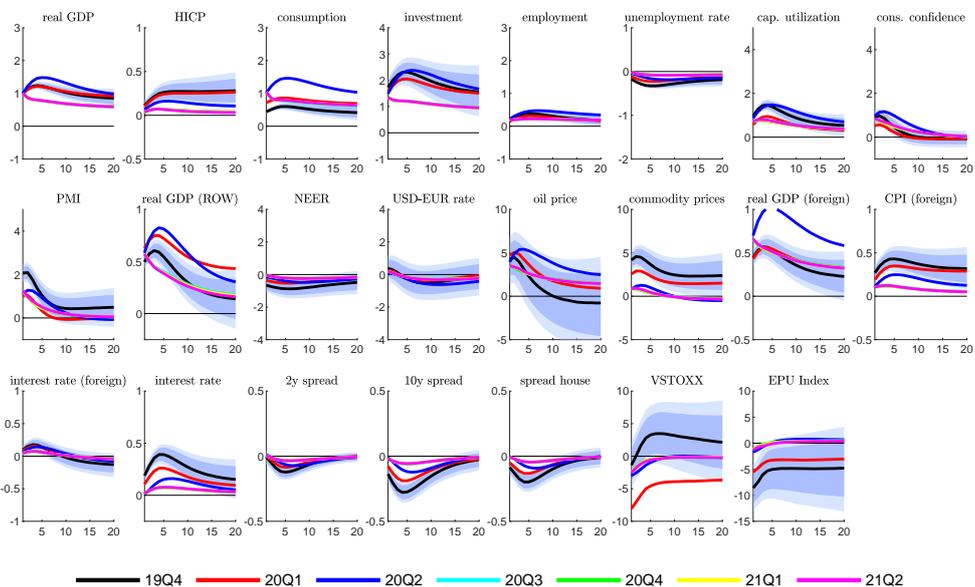
(a) BVAR with Gaussian errors



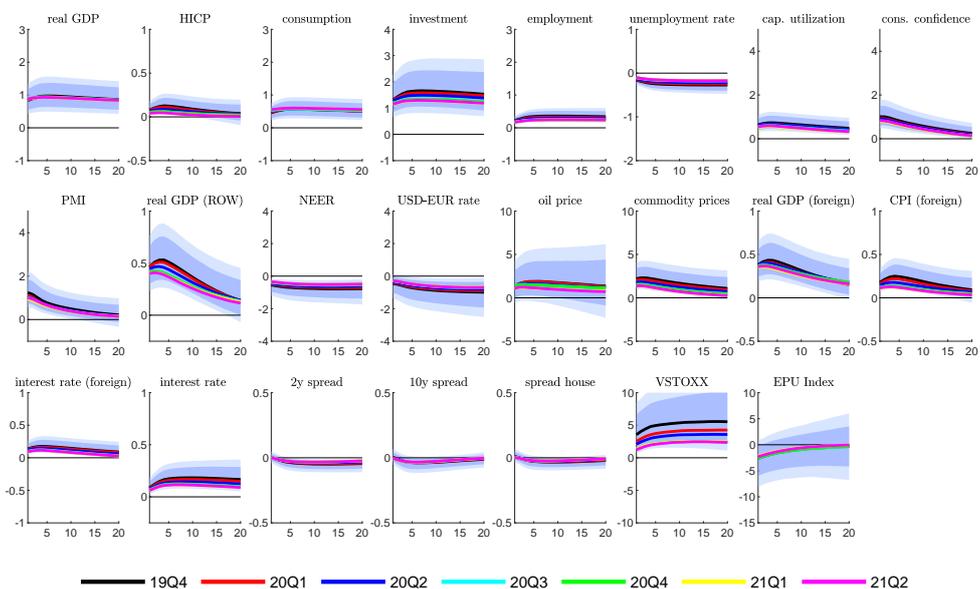
(b) BVAR with fat-tailed errors

Note: Impulse response functions to a one standard deviation shock in real GDP from a large BVAR with (a) Gaussian and (b) multivariate t -distributed errors using a Sims and Zha prior. Coloured thick lines are median estimates, and the dark (light) blue area is the 68% (90%) credible interval for the estimation window until 2019:Q4.

Figure B.6: Impulse response functions in a large BVAR (strong Sims and Zha prior)



(a) BVAR with Gaussian errors

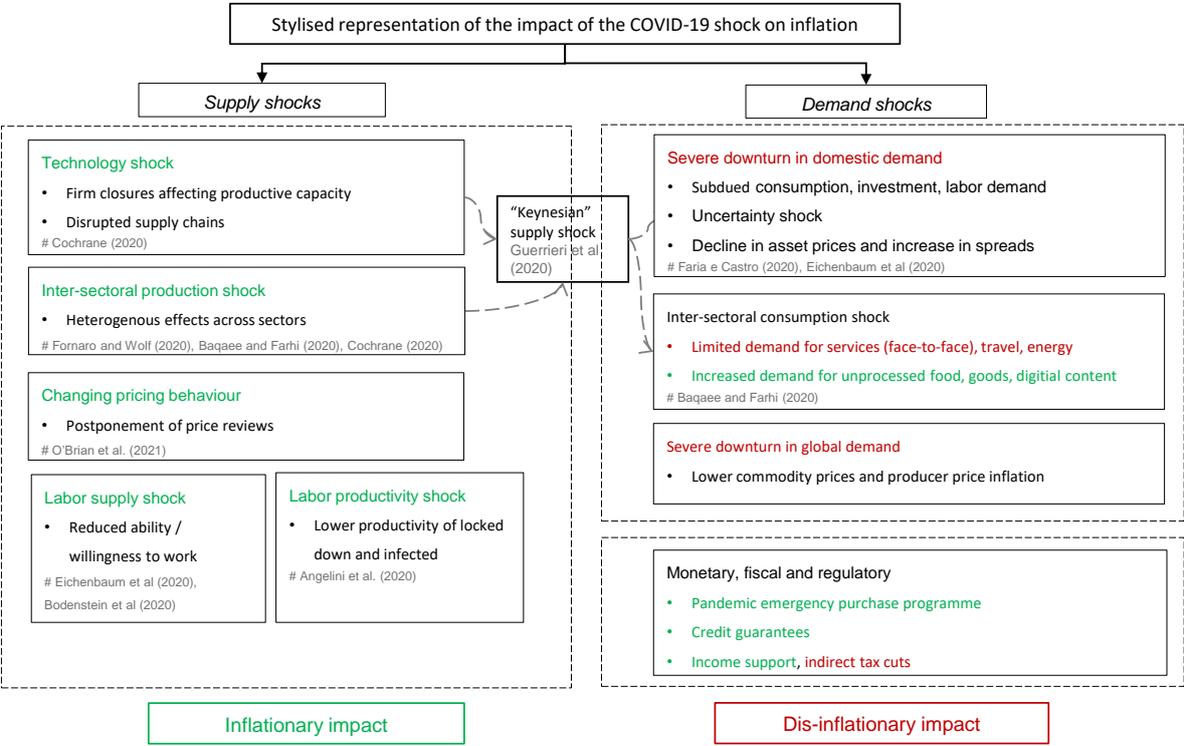


(b) BVAR with fat-tailed errors

Note: Impulse response functions to a one standard deviation shock in real GDP from a large BVAR with (a) Gaussian and (b) multivariate t -distributed errors using a strong Sims and Zha prior. Coloured thick lines are median estimates, and the dark (light) blue area is the 68% (90%) credible interval for the estimation window until 2019:Q4.

Stylised representation of the impact of the COVID-19 shock on inflation

Figure B.7: Impact of the COVID-19 shock on inflation



Note: The colour coding points to likely inflationary or disinflationary effects, but actual impacts are less straightforward. References underlying this figures are highlighted in gray; see [Angelini et al. \(2020\)](#), [Baqaee and Farhi \(2020\)](#), [Bodenstein et al. \(2020\)](#), [Cochrane \(2020\)](#), [Eichenbaum et al. \(2020\)](#), [Fornaro and Wolf \(2020\)](#), ([Guerrieri et al., 2020](#)) and [O'Brien et al. \(2021\)](#).

Pseudo out-of-sample forecast evaluation

Large BVAR (strong Sims and Zha prior)

Relative to the small VAR model, employing a larger information set improves the point prediction for both real GDP growth and, even more so, for HICP inflation during the pandemic (BVAR t), but the density prediction is slightly worse as compared to the small model. Note the evaluation period for the pre-pandemic forecast sample is shortened to the period 2005:Q1–2019:Q4 as the estimation starts in 1990:Q1.

Table B.1: Pseudo out-of-sample forecast evaluation (large BVAR)

(a) Real GDP growth

	RMSFE				ACRPS				ALPL			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
BVAR	0.56	1.04	1.49	1.91	0.26	0.49	0.72	0.96	-0.88	-1.47	-2.10	-2.56
BVAR t	0.62	1.13	1.60	2.02	0.28	0.54	0.81	1.08	-0.69	-1.33	-1.80	-2.18
(I) Pre-COVID-19 period: 2005:Q1–2019:Q4												
BVAR	8.18	10.07	10.62	11.65	5.29	6.30	7.10	8.29	-24.80	-63.85	-62.09	-60.93
BVAR t	7.33	8.63	8.83	9.57	4.99	5.64	6.30	7.55	-5.37	-5.64	-6.06	-7.31
BVAR D	7.43	8.84	9.00	9.74	5.00	5.69	6.28	7.45	-67.66	-87.60	-70.61	-76.74
(II) COVID-19 period: 2020:Q1–2021:Q2												

(b) HICP inflation

	RMSFE				ACRPS				ALPL			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
BVAR	0.33	0.60	0.85	1.11	0.18	0.33	0.47	0.63	-0.38	-0.93	-1.31	-1.61
BVAR t	0.34	0.62	0.86	1.10	0.20	0.36	0.50	0.65	-0.41	-1.03	-1.38	-1.67
(I) Pre-COVID-19 period: 2005:Q1–2019:Q4												
BVAR	0.47	0.70	1.11	1.36	0.27	0.44	0.70	0.85	-0.67	-1.14	-1.63	-1.90
BVAR t	0.48	0.71	0.92	1.05	0.28	0.46	0.60	0.64	-0.76	-1.31	-1.62	-1.67
BVAR D	0.46	0.67	1.00	1.23	0.27	0.42	0.63	0.77	-0.65	-1.09	-1.53	-1.80
(II) COVID-19 period: 2020:Q1–2021:Q2												

Note: Forecast evaluation metrics prior and during COVID-19 pandemic for (a) real GDP growth and (b) HICP inflation. BVAR denotes the Gaussian BVAR, BVAR t is the fat-tailed BVAR and BVAR D is the BVAR augmented with dummy variables for each quarter in the COVID-19 period.

Cross-country evidence for small BVAR

Table B.2: Cross-country forecast evaluation: RMSFE (relative to standard BVAR)

(a) Real GDP growth

	BVAR				BVAR t				BVAR D			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
CAN	0.57	1.06	1.46	1.78	1.00	0.98	0.98	0.99	•	•	•	•
DEU	0.85	1.36	1.87	2.34	1.00	0.99	0.98	0.97	•	•	•	•
ESP	0.48	0.90	1.34	1.81	1.04	1.05	1.06	1.08	•	•	•	•
FRA	0.39	0.68	0.99	1.25	1.02	1.02	1.03	1.03	•	•	•	•
GBR	0.48	0.91	1.36	1.76	1.02	1.00	0.99	0.97	•	•	•	•
ITA	0.60	1.09	1.55	1.98	1.04	1.03	1.03	1.02	•	•	•	•
JPN	1.04	1.62	2.18	2.63	0.97	0.95	0.94	0.92	•	•	•	•
USA	0.56	0.92	1.28	1.60	0.99	0.99	0.97	0.97	•	•	•	•

(I) Pre-COVID-19 period: 1995:Q1–2019:Q4

CAN	7.24	9.63	10.62	10.50	0.89	0.84	0.81	0.81	0.89	0.85	0.82	0.81
DEU	6.27	7.61	7.60	8.55	0.91	0.87	0.85	0.85	0.92	0.89	0.86	0.85
ESP	13.43	18.36	21.52	24.79	0.80	0.73	0.67	0.63	0.80	0.72	0.65	0.60
FRA	14.08	21.21	28.58	37.42	0.70	0.55	0.42	0.34	0.71	0.57	0.44	0.35
GBR	13.66	17.61	19.67	23.01	0.84	0.75	0.70	0.67	0.85	0.78	0.72	0.69
ITA	11.28	14.93	17.35	20.09	0.80	0.71	0.64	0.60	0.81	0.74	0.66	0.62
JPN	4.51	6.10	6.71	7.23	0.93	0.88	0.89	0.89	0.93	0.89	0.88	0.87
USA	5.77	7.41	8.41	8.88	0.89	0.84	0.81	0.79	0.90	0.86	0.83	0.81

(II) COVID-19 period: 2020:Q1–2021:Q2

(b) HICP inflation

	BVAR				BVAR t				BVAR D			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
CAN	0.45	0.77	1.01	1.23	0.96	0.93	0.90	0.87	•	•	•	•
DEU	0.29	0.47	0.65	0.85	0.97	0.94	0.91	0.90	•	•	•	•
ESP	0.45	0.82	1.18	1.53	1.00	1.00	1.00	1.00	•	•	•	•
FRA	0.28	0.49	0.71	0.94	0.98	0.98	0.98	0.99	•	•	•	•
GBR	0.34	0.62	0.88	1.15	0.97	0.96	0.96	0.97	•	•	•	•
ITA	0.25	0.50	0.79	1.07	0.98	0.96	0.95	0.95	•	•	•	•
JPN	0.39	0.60	0.80	1.01	0.98	0.96	0.95	0.94	•	•	•	•
USA	0.47	0.81	1.08	1.29	1.00	0.99	0.99	0.99	•	•	•	•

(I) Pre-COVID-19 period: 1995:Q1–2019:Q4

CAN	0.78	1.46	2.08	2.62	0.85	0.80	0.77	0.71	0.87	0.86	0.85	0.85
DEU	0.67	1.09	1.28	1.47	1.01	1.02	0.94	0.84	1.01	1.00	0.95	0.91
ESP	0.75	1.33	1.62	1.96	0.94	0.98	0.92	0.78	0.90	0.91	0.78	0.70
FRA	0.44	0.78	1.21	1.76	0.79	0.69	0.58	0.53	0.84	0.72	0.53	0.52
GBR	0.42	0.63	0.70	0.58	1.06	1.12	1.24	1.50	0.97	1.05	1.04	0.96
ITA	0.33	0.82	1.34	1.69	0.85	0.77	0.69	0.62	0.93	0.91	0.87	0.82
JPN	0.41	0.22	0.57	0.55	0.97	1.13	0.96	1.07	0.99	1.05	0.96	0.92
USA	1.07	1.46	1.83	2.39	0.86	0.82	0.79	0.77	0.91	0.86	0.84	0.85

(II) COVID-19 period: 2020:Q1–2021:Q2

Note: Forecast evaluation metrics prior and during COVID-19 pandemic for (a) real GDP growth and (b) HICP inflation. BVAR denotes the Gaussian BVAR, BVAR t is the fat-tailed BVAR and BVAR D is the BVAR augmented with dummy variables for each quarter in the COVID-19 period.

Table B.3: Cross-country forecast evaluation: ACRPS (relative to standard BVAR)

(a) Real GDP growth

	BVAR				BVAR t				BVAR D			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
CAN	0.31	0.56	0.78	0.96	0.97	0.96	0.96	0.97	•	•	•	•
DEU	0.45	0.71	0.99	1.26	0.97	0.98	0.97	0.97	•	•	•	•
ESP	0.27	0.47	0.70	0.95	0.91	1.00	1.03	1.06	•	•	•	•
FRA	0.21	0.37	0.54	0.68	1.00	1.01	1.01	1.01	•	•	•	•
GBR	0.27	0.48	0.70	0.90	0.97	0.96	0.95	0.93	•	•	•	•
ITA	0.33	0.56	0.80	1.04	1.01	1.02	1.01	1.01	•	•	•	•
JPN	0.54	0.85	1.14	1.39	0.97	0.95	0.94	0.93	•	•	•	•
USA	0.30	0.48	0.68	0.86	0.98	0.97	0.96	0.95	•	•	•	•

(I) Pre-COVID-19 period: 1995:Q1–2019:Q4

CAN	4.74	6.29	6.95	6.76	0.89	0.86	0.86	0.88	0.89	0.86	0.85	0.86
DEU	3.96	4.58	4.85	5.83	0.95	0.92	0.86	0.91	0.94	0.92	0.86	0.88
ESP	8.47	11.20	13.69	16.23	0.84	0.81	0.77	0.76	0.83	0.78	0.74	0.73
FRA	8.59	13.08	16.17	19.70	0.76	0.62	0.53	0.47	0.78	0.65	0.55	0.49
GBR	8.96	11.28	13.24	15.30	0.87	0.79	0.76	0.80	0.89	0.81	0.77	0.82
ITA	7.27	9.78	10.97	12.54	0.86	0.75	0.68	0.71	0.88	0.80	0.71	0.73
JPN	2.86	3.94	4.30	4.69	0.94	0.93	0.90	0.92	0.94	0.91	0.87	0.88
USA	3.84	5.01	5.63	5.57	0.86	0.85	0.86	0.89	0.86	0.85	0.85	0.87

(II) COVID-19 period: 2020:Q1–2021:Q2

(b) HICP inflation

	BVAR				BVAR t				BVAR D			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
CAN	0.24	0.41	0.54	0.67	0.97	0.93	0.90	0.88	•	•	•	•
DEU	0.17	0.27	0.36	0.47	0.96	0.93	0.90	0.89	•	•	•	•
ESP	0.25	0.45	0.64	0.84	1.00	1.00	0.99	1.00	•	•	•	•
FRA	0.16	0.28	0.40	0.53	0.98	0.98	0.98	0.98	•	•	•	•
GBR	0.19	0.34	0.49	0.65	0.98	0.98	0.98	0.99	•	•	•	•
ITA	0.14	0.28	0.44	0.60	0.97	0.96	0.96	0.95	•	•	•	•
JPN	0.20	0.32	0.44	0.55	0.98	0.96	0.95	0.94	•	•	•	•
USA	0.23	0.41	0.56	0.70	0.99	0.98	0.98	0.98	•	•	•	•

(I) Pre-COVID-19 period: 1995:Q1–2019:Q4

CAN	0.48	0.89	1.20	1.38	0.84	0.81	0.80	0.77	0.85	0.85	0.86	0.88
DEU	0.34	0.66	0.80	0.85	1.07	1.08	0.98	0.88	1.02	1.00	0.95	0.93
ESP	0.45	0.77	0.86	0.93	0.96	1.04	1.09	1.02	0.89	0.90	0.83	0.80
FRA	0.25	0.42	0.54	0.78	0.81	0.76	0.73	0.68	0.85	0.80	0.68	0.68
GBR	0.26	0.37	0.45	0.46	1.04	1.12	1.15	1.18	0.97	1.03	0.99	0.93
ITA	0.19	0.47	0.71	0.81	0.87	0.79	0.75	0.73	0.94	0.90	0.88	0.86
JPN	0.24	0.17	0.33	0.34	0.98	1.01	0.96	1.04	0.99	1.02	0.97	0.96
USA	0.69	0.88	1.02	1.21	0.86	0.84	0.82	0.80	0.90	0.85	0.84	0.88

(II) COVID-19 period: 2020:Q1–2021:Q2

Note: Forecast evaluation metrics prior and during COVID-19 pandemic for (a) real GDP growth and (b) HICP inflation. BVAR denotes the Gaussian BVAR, BVAR t is the fat-tailed BVAR and BVAR D is the BVAR augmented with dummy variables for each quarter in the COVID-19 period.

Table B.4: Cross-country forecast evaluation: ALPL (relative to standard BVAR)

(a) Real GDP growth

	BVAR				BVAR t				BVAR D			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
CAN	-1.02	-1.48	-1.78	-1.98	0.03	0.04	0.05	0.03	•	•	•	•
DEU	-1.38	-1.76	-2.06	-2.28	0.07	0.08	0.07	0.07	•	•	•	•
ESP	-1.06	-1.43	-1.76	-2.04	0.19	0.10	0.05	0.01	•	•	•	•
FRA	-0.54	-1.03	-1.40	-1.66	-0.03	-0.01	0.01	0.03	•	•	•	•
GBR	-0.86	-1.34	-1.72	-2.03	0.04	0.07	0.11	0.19	•	•	•	•
ITA	-1.01	-1.50	-1.85	-2.17	-0.01	0.03	0.06	0.13	•	•	•	•
JPN	-1.49	-1.88	-2.21	-2.39	0.05	0.06	0.13	0.12	•	•	•	•
USA	-0.95	-1.37	-1.66	-1.88	0.03	0.05	0.05	0.05	•	•	•	•
(I) Pre-COVID-19 period: 1995:Q1–2019:Q4												
CAN	-22.32	-30.28	-27.08	-21.13	17.61	24.57	21.06	15.01	-6.33	-10.76	-13.84	0.65
DEU	-10.59	-10.02	-8.01	-8.86	6.09	5.19	3.49	3.57	-0.01	-2.43	-1.71	1.14
ESP	-40.16	-94.08	-95.86	-84.18	34.32	87.75	88.47	75.68	-32.74	-12.66	-2.60	-10.63
FRA	-66.85	-220.22	-241.98	-213.29	60.13	212.23	233.93	204.63	-141.48	-67.72	-25.38	-50.09
GBR	-81.55	-136.18	-123.66	-130.39	74.60	128.88	115.72	121.24	-66.36	-43.55	-40.39	-52.59
ITA	-36.08	-72.45	-74.41	-61.29	29.99	66.04	68.38	53.68	-31.70	-13.06	-2.16	-25.53
JPN	-5.79	-6.67	-5.55	-5.17	2.34	2.61	1.61	1.02	0.07	0.67	-0.70	-0.25
USA	-18.03	-24.18	-19.93	-16.91	13.34	18.56	13.86	11.13	-4.83	-4.72	-1.27	-1.61
(II) COVID-19 period: 2020:Q1–2021:Q2												

(b) HICP inflation

	BVAR				BVAR t				BVAR D			
	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 1$	$h = 2$	$h = 3$	$h = 4$
CAN	-0.72	-1.17	-1.44	-1.66	0.04	0.06	0.09	0.12	•	•	•	•
DEU	-0.42	-0.80	-1.08	-1.33	0.07	0.08	0.10	0.11	•	•	•	•
ESP	-0.76	-1.25	-1.60	-1.86	-0.04	-0.02	-0.01	-0.02	•	•	•	•
FRA	-0.33	-0.80	-1.15	-1.42	0.04	0.03	0.03	0.03	•	•	•	•
GBR	-0.55	-1.01	-1.33	-1.59	0.03	0.01	0.01	0.00	•	•	•	•
ITA	-0.26	-0.81	-1.22	-1.53	0.05	0.05	0.04	0.04	•	•	•	•
JPN	-0.55	-0.93	-1.21	-1.44	0.07	0.07	0.07	0.08	•	•	•	•
USA	-0.70	-1.28	-1.55	-1.69	0.15	0.19	0.15	0.06	•	•	•	•
(I) Pre-COVID-19 period: 1995:Q1–2019:Q4												
CAN	-1.17	-1.85	-2.15	-2.23	0.11	0.18	0.17	0.21	0.14	0.21	0.17	0.11
DEU	-1.13	-1.84	-1.78	-1.77	0.16	-0.02	-0.08	0.05	-0.02	-0.01	0.08	0.07
ESP	-1.14	-1.80	-1.74	-1.78	-0.06	-0.03	-0.23	-0.24	0.07	0.09	0.11	0.09
FRA	-0.57	-1.07	-1.22	-1.53	0.09	0.13	0.11	0.15	0.07	0.10	0.12	0.14
GBR	-0.70	-1.09	-1.30	-1.43	-0.06	-0.07	-0.10	-0.06	0.02	0.00	0.02	0.05
ITA	-0.39	-1.16	-1.53	-1.59	0.04	0.15	0.18	0.14	0.03	0.11	0.12	0.10
JPN	-0.58	-0.61	-0.98	-1.10	-0.01	0.03	0.00	-0.02	0.00	-0.01	0.01	0.02
USA	-1.79	-1.98	-2.04	-2.23	0.19	0.20	0.23	0.26	0.20	0.25	0.26	0.15
(II) COVID-19 period: 2020:Q1–2021:Q2												

Note: Forecast evaluation metrics prior and during COVID-19 pandemic for (a) real GDP growth and (b) HICP inflation. BVAR denotes the Gaussian BVAR, BVAR t is the fat-tailed BVAR and BVAR D is the BVAR augmented with dummy variables for each quarter in the COVID-19 period.

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